

I CLAIM:

- 1 1. A Polymer Electrolyte Membrane (PEM) fuel cell Membrane Electrode
2 Assembly (MEA) apparatus comprising:
3 a conductive planar substrate having a front surface and an opposing
4 back surface, the planar substrate also having a porous region;
5 catalyst material affixed to at least said back surface of said porous
6 region;
7 polymer electrolyte material affixed to said front surface of said planar
8 substrate, the polymer electrolyte material having an anode surface and an
9 opposing cathode surface;
10 an anode conductor coupled with said anode surface of said polymer
11 electrolyte material;
12 a gas-diffusion electrode affixed to said anode conductor; and
13 a cathode conductor electrically coupled to the conductive substrate
14 through an opening in the polymer electrolyte material.
- 1 2. An MEA according to claim 1 further comprising a layered stack of catalyst
2 and palladium disposed between said front surface of said porous region of said
3 planar substrate and said polymer electrolyte material.
- 1 3. An MEA according to claim 1 further comprising a transition layer disposed
2 between said polymer electrolyte material and said anode conductor for
3 improving catalysis of fuel.
- 1 4. An MEA according to claim 1 further comprising a water barrier adjacent to
2 said back surface catalyst material.

1 5. An MEA according to claim 1 wherein said anode conductor and said cathode
2 conductor are coplanar.

1 6. An MEA according to claim 1 wherein said polymer electrolyte material is less
2 than approximately 30 microns thick.

1 7. An MEA according to claim 1 wherein said polymer electrolyte material is less
2 than approximately 5 microns thick.

1 8. An MEA according to claim 1 wherein said polymer electrolyte material is less
2 than approximately 1 micron thick.

1 9. An MEA according to claim 1 wherein said polymer electrolyte material
2 comprises a perfluorocarbon copolymer proton-conducting material.

1 10. An MEA according to claim 1 wherein said polymer electrolyte material
2 comprises NAFION, a registered trademark of I.E. DuPont Nemours and
3 Company.

1 11. An MEA according to claim 1 wherein said catalyst material comprises one
2 or more metals chosen from the group consisting of platinum, iridium, palladium,
3 rhodium, molybdenum, gold, and nickel.

1 12. An MEA according to claim 1 wherein said catalyst material comprises
2 platinum.

1 13. An MEA according to claim 1 wherein said catalyst material comprises an
2 alloy of platinum and rhodium.

1 14. An MEA according to claim 1 wherein said substrate comprises silicon.

1 15. An MEA according to claim 1 wherein said substrate comprises a conductive
2 silicon layer on sapphire.

1 16. An MEA according to claim 1 wherein said substrate comprises one or more
2 semiconductor compound selected from the group known as the III-V family.

1 17. An MEA according to claim 1 further comprising a fuel cell body operably
2 connected to said MEA portion.

1 18. An MEA according to claim 1 further comprising an electronic circuit portion
2 of said substrate and operably coupled to said anode conductor and said
3 cathode conductor.

1 19. An MEA according to claim 18 wherein said electronic circuit is integral with
2 said membrane electrode assembly.

1 20. An integrated circuit based fuel cell apparatus comprising:
2 a Polymer Electrolyte Membrane (PEM) fuel cell Membrane Electrode
3 Assembly (MEA); and
4 an integrated circuit operably coupled to said membrane electrode
5 assembly.

1 21. An integrated circuit based fuel cell apparatus according to claim 20 wherein
2 said integrated circuit comprises a fuel cell control circuit.

1 22. An integrated circuit based fuel cell apparatus according to claim 20 wherein
2 said integrated circuit comprises a driven device.

1 23. An integrated circuit based fuel cell apparatus according to claim 20 further
2 comprising a fuel cell body operably connected to said MEA.

1 24. An integrated circuit based fuel cell apparatus according to claim 20 further
2 comprising a planar substrate.

1 25. An integrated circuit based fuel cell apparatus according to claim 24 wherein
2 said MEA further comprises a porous region of said planar substrate.

1 26. An integrated circuit based fuel cell apparatus according to claim 24 wherein
2 said planar substrate comprises silicon.

1 27. An integrated circuit based fuel cell apparatus according to claim 24 wherein
2 said planar substrate comprises a conductive silicon layer on sapphire.

1 28. An integrated circuit based fuel cell apparatus according to claim 24 wherein
2 said substrate comprises one or more semiconductor compound selected from
3 the group known as the III-V family.

1 29. An integrated circuit based fuel cell apparatus according to claim 20 wherein
2 said polymer electrolyte material comprises a perfluorocarbon copolymer proton-
3 conducting material.

1 30. An integrated circuit based fuel cell apparatus according to claim 20 wherein
2 said polymer electrolyte material comprises NAFION, a registered trademark of
3 I.E. DuPont Nemours and Company.

1 31. An integrated circuit based fuel cell apparatus according to claim 20 wherein
2 said polymer electrolyte material is less than approximately 30 microns thick.

1 32. An integrated circuit based fuel cell apparatus according to claim 20 wherein
2 said polymer electrolyte material is less than approximately 5 microns thick.

1 33. An integrated circuit based fuel cell apparatus according to claim 20 wherein
2 said polymer electrolyte material is less than approximately 1 micron thick.

1 34. An integrated circuit based fuel cell apparatus according to claim 20 wherein
2 said MEA further comprises a catalyst comprising one or more metals selected
3 from the group platinum, iridium, palladium, rhodium, molybdenum, gold, and
4 nickel.

1 35. An integrated circuit based fuel cell apparatus according to claim 20 wherein
2 said MEA further comprises a catalyst further comprising platinum.

1 36. An integrated circuit based fuel cell apparatus according to claim 20 wherein
2 said MEA further comprises a catalyst further comprising an alloy of platinum
3 and rhodium.

1 37. An integrated circuit comprising:
2 a substrate having a Polymer Electrolyte Membrane (PEM) fuel cell
3 Membrane Electrode Assembly (MEA) portion further comprising:
4 a porous region of said planar substrate having a front surface and an
5 opposing back surface;
6 catalyst material affixed to said back surface and sidewalls of said porous
7 region;
8 polymer electrolyte material affixed to said front surface of planar
9 substrate, the polymer electrolyte material having an anode surface and an
10 opposing cathode surface;
11 an anode conductor coupled with said anode surface of said polymer
12 electrolyte material;
13 a gas-diffusion electrode affixed to said anode conductor;
14 a cathode conductor electrically coupled with said conductive portion of
15 substrate wherein said cathode conductor is coplanar in relation to said anode
16 conductor; and
17 said substrate also having an integrated circuit portion operably coupled
18 to said MEA portion.

1 38. An integrated circuit according to claim 37 wherein said integrated circuit
2 portion comprises a fuel cell control circuit.

1 39. An integrated circuit according to claim 37 wherein said integrated circuit
2 portion comprises a driven device.

1 40. An integrated circuit according to claim 37 further comprising a fuel cell body
2 operably connected to said MEA portion.

1 41. An integrated circuit according to claim 37 wherein said planar substrate
2 comprises silicon.

1 42. An integrated circuit according to claim 37 wherein said planar substrate
2 comprises silicon and sapphire.

1 43. An integrated circuit according to claim 37 wherein said substrate comprises
2 one or more semiconductor compound selected from the group known as the III-
3 V family.

1 44. An integrated circuit according to claim 37 wherein said polymer electrolyte
2 material comprises a perfluorocarbon copolymer proton-conducting material.

1 45. An integrated circuit according to claim 37 wherein said polymer electrolyte
2 material comprises NAFION, a registered trademark of I.E. DuPont Nemours and
Company.

1 46. An integrated circuit according to claim 37 wherein said polymer electrolyte
2 material is less than approximately 30 mils thick.

1 47. An integrated circuit according to claim 37 wherein said polymer electrolyte
2 material is less than approximately 5 mils thick.

1 48. An integrated circuit according to claim 37 wherein said polymer electrolyte
2 material is less than approximately 1 mil thick.

1 49. An integrated circuit according to claim 37 wherein said catalyst comprises
2 one or more metals selected from the group platinum, iridium, palladium, gold,
3 and nickel.

1 50. An integrated circuit according to claim 37 wherein said catalyst comprises
2 platinum.

1 51. An integrated circuit according to claim 37 wherein said catalyst comprises
2 an alloy of platinum and rhodium.

1 52. An integrated circuit according to claim 37 further comprising a layered stack
2 of catalyst and palladium disposed between said front surface of said porous
3 region of said planar substrate and said polymer electrolyte material.

1 53. An integrated circuit according to claim 37 further comprising a transition
2 layer disposed between said polymer electrolyte material and said anode
3 conductor for lowering lateral electrical resistance.

1 54. An integrated circuit according to claim 37 further comprising a water barrier
2 adjacent to said back surface catalyst material.